Cassidy, A. 'One Health? Building an interdisciplinary bandwagon at the interfaces of animal health, human health and the environment' in Scott Frickel, Mathieu Albert, & Barbara Prainsack (eds.) *Investigating Interdisciplinary Research: Theory and Practice across Disciplines*. Rutgers University Press, 2016.
Final manuscript to publisher: please contact the author before citing or quoting.

One Health? Building an interdisciplinary bandwagon at the interfaces of animal health, human health and the environment

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Introduction

Since the mid-2000s, international agencies, veterinary associations, NGOs and funding bodies have issued calls of increasing frequency and volume advocating greater integration across the domains of human, animal and environmental health. Citing threats to health from climate change, food insecurity and emerging infectious diseases, alongside the similarity of disease processes across humans and animals, advocates have lobbied for the broader integration of health research, policy and clinical practice, using slogans including 'One World One Health' (Wildlife Conservation Society, 2010); 'One Medicine' (Schwabe, 1984), and 'One World-One Medicine-One Health' (Kahn, Kaplan and Monath, 2012). In recent years, 'One Health' (OH) has been increasingly adopted as a catch-all term by actors across a broadening range of scientific, medical and professional disciplines, particularly veterinary medicine, global health and infectious diseases. But what does 'One Health' actually mean? Where has OH come from, how is it used, in what contexts, by which actors, and how has it come to prominence in such a short space of time?

Perhaps the most widely used working definition is the one put forward by the One Health Initiative, a US-based advocacy group including veterinarians, physicians, public and environmental health professionals: "The One Health concept is a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment" (Kahn, Kaplan and Monath, 2012). This definition is strikingly broad, promoting 'interdisciplinary collaboration' without specifying who should be collaborating with whom and on what, or indeed how they should actually go about it. This is reflected in varying references to OH as a 'concept', as above, but also as an 'approach', a 'movement', and even a 'paradigm'. In recent years, the language of One Health has been adopted by a series of powerful actors in biomedicine and global health, including the US government's Centers for Disease Control (CDC, 2013), international organisations including the Food and Agriculture Organisation (FAO), World Health Organisation (WHO) and World Organisation for Animal Health (OIE) (FAO et al, 2008; 2010) and the biomedical research funders Wellcome Trust (2013) and Gates Foundation (2013).

Given the influence of these institutions in shaping health research, policy and practice globally, it is important to understand why OH has had so much traction with these actors. Perhaps they have been convinced by the arguments - even if the main priority is to improve human health, understanding why and how, for example, infectious diseases move between multiple species can bring obvious benefits. However, arguments about why we should think across humans and animals about health and medicine are far from new, and have been advanced from time to time ever since veterinary medicine emerged as a separate profession during the late 18th century (Woods and

Bresalier, 2014; Bresalier, Cassidy and Woods, 2015). Animals have regularly played important roles in the history of medicine, as bodies to experiment on, as sources of theoretical insight, and as objects of enquiry in their own right (Hardy, 2003; Kirk and Worboys, 2011). This raises an obvious question: given that ideas about the convergence of human and animal health have had such a long history, why have they only gained significant international and institutional traction so recently? In other words, the key question is not why One Health, but why One Health now?

This chapter will explore the recent emergence of OH as the self-identified, broad based, interdisciplinary agenda we see today, and will trace its origins in the histories of human and animal health, global development, conservation and infectious diseases. It will also investigate OH as an example of the increasing popularity of interdisciplinarity across changing academic, professional and policy landscapes of the early 21st century. What is the relationship between OH and other interdisciplinary agendas such as food security, what can this tell us about how these agendas are built and why? Itself the outcome of an interdisciplinary collaboration,[1] the research underlying this chapter has adopted a longitudinal, contemporary-historical approach. It has investigated OH as part of ongoing interactions between scientific, professional and policy spheres, while following the construction and spread of OH ideas and terminology over time and across multiple disciplines. The research has investigated a series of questions following from 'why OH now?' What has happened to bring this agenda to the fore in biomedicine and global health, and to be adopted so widely over such a short period of time? Who are the key actors in this process, when did they become involved, and what does OH mean to them? What broader agendas and disciplinary interests are driving the uptake of OH? What forms of interdisciplinary and cross-disciplinary partnership have been advocated, by which actors and when?[2] How have these discourses related to collaborative practice? Following the work of Jacobs and Frickel (2009), is interdisciplinarity in OH 'bottom-up' (generated by amongst working researchers) or 'top-down' (imposed by institutions)?

While the vast majority of publications discussing OH come from biomedical and health oriented authors, there is a small but rapidly developing social science and humanities (SSH) literature on the topic. This has taken two main forms: social scientists adopting OH to work collaboratively with natural scientists on human and animal health research (e.g. Wood et al, 2012) and scholarship investigating OH itself. For the purposes of clarity, this chapter will refer to OH as an 'agenda', and will build upon the latter body of work which, paradoxically enough, starts with studies of disciplinarity, the problems it can cause, and the reasons why OH actors reach out beyond their own disciplines. Several scholars researching OH have pointed towards mid-2000s crises over threats of a global influenza pandemic as the most immediate driver (Scoones and Forster, 2010). What these researchers and OH actors have described as the traditional disciplinary 'silos' (tightly contained organisations) responsible for human health, animal health, food and environment proved to be a major barrier to effectively managing diseases that moved freely across these domains (Jerolmack, 2013). The intensity of concerns over pandemic risks drove a well-funded international response to these disease threats, which in turn drove greater co-operation across the silos of OH. During this process the international agencies FAO, WHO and OIE adopted OH to signal their co-operative intent. Several studies have explored the breadth and conceptual flexibility of OH, as demonstrated above. While some have identified this flexibility as a key weakness, diffusing the idea beyond any useful meaning and acting as a barrier to further action (Lee and Brumme, 2012), others have argued that

this breadth enables OH to act as an "umbrella' under which OH actors can articulate a range of "slightly different visions" while working together (Leboeuf, 2011, p64-66).

Developing this theme, Chien (2013) concluded that the "productive vagueness" (p10) of OH enabled FAO, WHO and OIE to move from mutually exclusive understandings of avian influenza towards a collective reframing which enhanced their interests, while minimizing inter-agency tensions. Chien drew upon Star and Griessemer's (1989) classic study of 'boundary-objects' in scientific collaboration: concepts concrete enough to articulate common ideas across several 'social worlds' (groups of people working towards a shared goal), yet flexible enough to be reinterpreted to fit the particular needs of each of these groups.[3] Chien argued that OH acts as a boundary-object for actors pushed into working together across the silo'd social worlds of international health. However, as Star (2010) later discussed, boundary-objects are not simply words with multiple meanings: they must be understood as the product of ongoing processes of social negotiation, and tend to operate at the scale of organisations, rather than in the details of interpersonal relationships or larger social structures.

By focusing on the international health organisations, Chien's analysis ably demonstrates how OH functions as a boundary object at a very specific "scope and scale" (Star, 2010, p612-3). However, by doing so, it cannot engage with how OH has been mobilised beyond this particular context, nor its relationship with scientific and medical practice more generally. Boundary-objects function not only as collaborative tools, but also as markers of political negotiations between social worlds, especially in the case of academic disciplines. By using boundary-objects strategically, individual and institutional actors can claim legitimacy, gain allies and bring about changes in working practices (Lowy, 1992). In her studies of the adoption and spread of molecular biology into cancer research during the 1980s, sociologist Joan Fujimura (argued that the use of boundary-objects is one of several techniques employed by scientists when working across social worlds: another is the standardisation of theories and of experimental techniques. Fujimura analysed the growth of molecular biology, observing how the research agenda was initially constructed, then scientific allies were then successfully enrolled via boundary-objects and standardisation. She characterises this overall process as the 'scientific bandwagon', which involves two key stages: initially progressing slowly as key actors develop and advance their ideas while negotiating meanings and alliances, then speeding up and expanding to run under its own momentum once it has gathered sufficient recognition, support and resources.

This chapter will build upon Fujimura's notion of the scientific bandwagon in order to understand the recent and rapid rise of the OH agenda. While OH fits well with Fujimura's description in many respects, there are some key differences, particularly around the foregrounding of interdisciplinarity, the applied nature of the agenda, and the prominence of institutional actors alongside scientific practitioners. I argue that OH shares these features with several adjacent agendas which it mutually enrols, including food security and translational medicine, and that these may all be examples of a new style of agenda building across 21st century science, medicine and policy: the 'interdisciplinary bandwagon'.

Methods

In order to understand OH more broadly, particularly as an explicitly interdisciplinary agenda, this chapter will follow OH via the usage of specific terms, in much the same way that other scholars have 'followed' technologies, organisms or diseases (e.g. Goedeke and Rikoon, 2008; Scheffler, 2014). As demonstrated in Ariane Dröscher's (2012) study of the usage of 'stem cell' in 20th century biology, following terminology can be an effective approach to tracing the spread of ideas and agendas: it is indicative not only of key issues of concern, but can also tell us about the strategic agendas, origins and broader meanings bound up with those issues. In the increasingly interconnected domains of science/medicine/policy/industry in the early 21st century, the creation and adoption of such 'buzzwords' has become increasingly ubiquitous (Bensaude Vincent, 2014). Therefore following the terminology of OH can be particularly productive, given that defining the meaning and origins of 'one health' appears to be a key concern amongst its own advocates. This chapter draws upon search results from the citation database Web of Science, initially for the phrase 'One Health', then for a series of associated terms: 'one medicine', 'one world' AND health', 'comparative medicine' and 'veterinary public health'. The results were cleaned to remove irrelevant references (e.g. the phrase 'one health authority'), and multiple hits from conference proceedings, leaving only journal articles discussing OH. These were analysed using bibliometrics to chart changes in usage levels over time and across fields. Alongside these indicators, the articles were also analysed qualitatively to identify key actors, fields, terminology, and variations in the scope, aims and meanings of OH. The qualitative analysis also drew upon the results of Google searching for these phrases, revealing the online presence of OH and the existence of a policy oriented 'grey literature'. Several OH workshops and conferences were attended and a series of exploratory interviews with OH actors was conducted, providing background information. This enabled the development of OH to be located within a broader and longer historical context than the immediate post 2000 visibility of the term itself.

Having already introduced OH, this chapter will now outline the meanings, histories and disciplinary origins of several terms which actors have used alongside or instead of 'one health' to describe their aims and activities, illustrating the varying ideas which sit together under the OH umbrella. Once these have been explored, the chapter will move on to discuss the bibliometric analysis of OH terminology in journal articles, showing when and how these ideas have come together. Finally the implications of these findings will be discussed, for our understanding of the OH agenda and of interdisciplinary agenda building more generally.

Veterinary Medicine and 'One Medicine'

As veterinary medicine emerged from human medicine in Europe during the late 1700s, doctors continued to work with animal patients until well into the nineteenth century. As such, veterinarians often sought to defend and distinguish their profession from its bigger and more powerful neighbour, as well as from other professions involved in the care of animals (Woods and Matthews, 2010). However, vets and doctors continued to work together under the right circumstances, and the insights from such collaborations, alongside the financial and status benefits, particularly for veterinarians, provided powerful incentives to do so. Over the past two hundred years, there have

been a series of veterinary agendas concerned with bringing animal and human health closer together (Bresalier, Cassidy and Woods, 2015). Comparative medicine involved the study of disease by comparing cases across a wide range of species, sometimes including humans, and was advocated and adopted by veterinary and zoological researchers from the late 19th century, gaining considerable traction from the 1920s onwards. By the middle of the century, comparative medicine was highly influential, guiding public health research programmes at the WHO for example. Comparative medicine then gradually lost prominence through the 1970s, and the term was adopted by researchers developing laboratory animal models for human clinical medical research, moving to a more anthropocentric mode of comparison (Michell, 2000). Unlike comparative medicine, veterinary public health (VPH) has had a more applied orientation, involving itself with policy, regulatory structures and public health, concerning itself with "…community efforts influencing and influenced by the veterinary medical arts and sciences applied to the prevention of diseases, protection of life and promotion of the well-being and efficiency of man"(WHO and FAO, 1951, p3). VPH has particularly concerned itself with controlling disease in domestic animals in order to prevent transmission to humans via food, and maintaining animal health in order to boost food production. Like comparative medicine, VPH originated in the 19th century but became much more prominent from the mid 20th century onwards, also becoming institutionalised at the WHO at this time, but instead continuing as an active approach into the present day.

'One medicine' is often regarded as the most direct precursor to 'one health': the term is now generally used to refer to the alliance or co-operation of veterinary and human medical research and clinical practice, including mutual exchanges in developing new procedures, equipment and drugs (e.g. Cardiff et al, 2008; Kaplan et al, 2009). Veterinary epidemiologist Calvin Schwabe is often credited by today's OH advocates as the originator of the term 'one medicine' in his 1984 textbook *Veterinary Medicine and Human Health* (Kaplan and Scott, 2011). This 700 page volume provided a fully articulated vision for reforming veterinary research, education and practice, using OM as the core organising principle. However, searching citation databases for the term reveals that OM had been in use several decades prior to Schwabe's book, particularly by a series of authors linked with the University of Pennsylvania (e.g. Allam, 1966; Cass, 1973; Schmidt, 1962). During the 1950s and '60s, medical and veterinary faculty at Penn collaborated closely and were involved in comparative medicine and VPH: today the veterinary school is a key advocate for OH (Hendricks et al, 2009). Unlike many of the terms under discussion here, OM was never defined in these texts: instead it tended to be used in a self-evident way that implied that readers were already familiar with the term. This continued in Schwabe (1984), where OM is used in section and chapter headings: however it was not defined and first appears in the body text as part of a historical summary. This suggests that OM was never formally 'coined', but may instead have arisen more organically in mid-20th C thinking about animal and human health. Following Schwabe's book (which was not highly cited until recently), OM re-emerged in the early 2000s, in further discussions of comparative medicine, VPH, and in pieces bringing them into alignment (e.g. Schwabe, 2004). Later in the decade, key veterinary and medical associations in North America agreed on and published a series of statements and organisations promoting 'One Medicine, One Health'(Kahn et al, 2008; King et al, 2008). These events - and the ideas behind them - were extensively discussed in veterinary journals such as the *Journal of the American Veterinary Medical Association*, the UK based *Veterinary Record* and *Veterinaria Italiana,* which published an open-access special issue devoted to the topic.

'One World' and its relationship with health

The idea and term 'One World' (OW) was developed by political philosophers during the Second World War, and became prominent during its aftermath, when the idea that national interests should be overcome in order to deal with international problems became highly compelling. While initially OW was articulated in the context of international relations and the formation of the UN, the idea was also instrumental in the formation of the international health agencies WHO and FAO (Brockington, 1958; Staples, 2011). The term OW was used by biologist Julian Huxley in his early leadership of UNESCO, and mobilised by actors in international health during postwar debates about population control and food supply (Bashford, 2014, Sluga, 2010). However, following this early period the term was rarely used in health contexts until it resurfaced during the 1990s, in health policy responses to the HIV/AIDS epidemic, as well as academic discussions of 'emerging infectious diseases', and the transition from 'international' to 'global' health (Anderson, 2004; King, 2004).

During the 2000s these debates continued and gained an additional focus with a new series of rapidly changing viral disease threats. In 2004, following the SARS outbreak, and as the H5N1 strain of avian influenza was spreading and causing widespread concern, a series of meetings themed on 'One World, One Health'® were organised, held initially in New York but subsequently at international locations such as China and Brazil. These meetings were organised by the US-based NGO the Wildlife Conservation Society[4] and sponsored by the Rockefeller Foundation. They were specifically focused on how to manage these infections, which travel freely across countries as well as between humans, domestic animals and wildlife, causing problems for human health, animal health and conservation agendas. Participants included the FAO and WHO, US governmental bodies including the CDC, research scientists and a range of other conservation, disease ecology, agricultural and public health actors (Wildlife Conservation Society, 2004). Over the following years these and other international health organisations started building closer working relationships, and when the H5N1 strain of avian influenza emerged, this process accelerated, driven by the international response to the outbreak. In 2008, international agencies including FAO, WHO, OIE and the World Bank adopted OWOH as an organising framework for a statement of co-operative intent, fostered by this international response (FAO et al, 2008). Since then OWOH has generally been used to highlight the interconnected nature of infectious disease as microorganisms pass between animals and humans via the wider environment. Advocates of OWOH argue such these diseases can therefore only be tackled by research and policy that encompasses these domains, and which takes a global perspective (Vallet, 2009). While concerns about viral pandemics appear to have provided the primary driver for the appearance of OWOH, advocates also point to a series of disease events over the past three decades which have highlighted the animal origins of much infectious disease. These included the HIV/AIDS epidemic, the BSE/CJD crisis in the UK, the discovery of new haemorrhagic fevers and resurgence of others, and the re-emergence of older disease problems such as malaria and TB.

Transitioning to 'One' Health

By the mid-2000s, both 'One Medicine' and 'One World, One Health' were in use across research and policy in human and animal health, but as we have seen their meanings (and the actors using them)

were somewhat different. While OM addressed only veterinary and human medicine, its scope included all forms of illness and clinical practice, including chronic disease and the treatment of injuries. Conversely OWOH involved a wider range of disciplines, including biological and environmental sciences, but was specifically concerned with infectious disease. The parallel statements in 2008, from the US veterinary/medical associations and from the international agencies mark a key turning point. While the statements did not cross-refer, actors involved in both agendas advocated a move to a single banner (Zinsstag et al, 2005), and by 2010 the international health agencies (FAO et al, 2010) had adopted OH. Figure One reflects this transition in the usage of OH and related terms in academic journal publications from 1990 until the end of 2013.

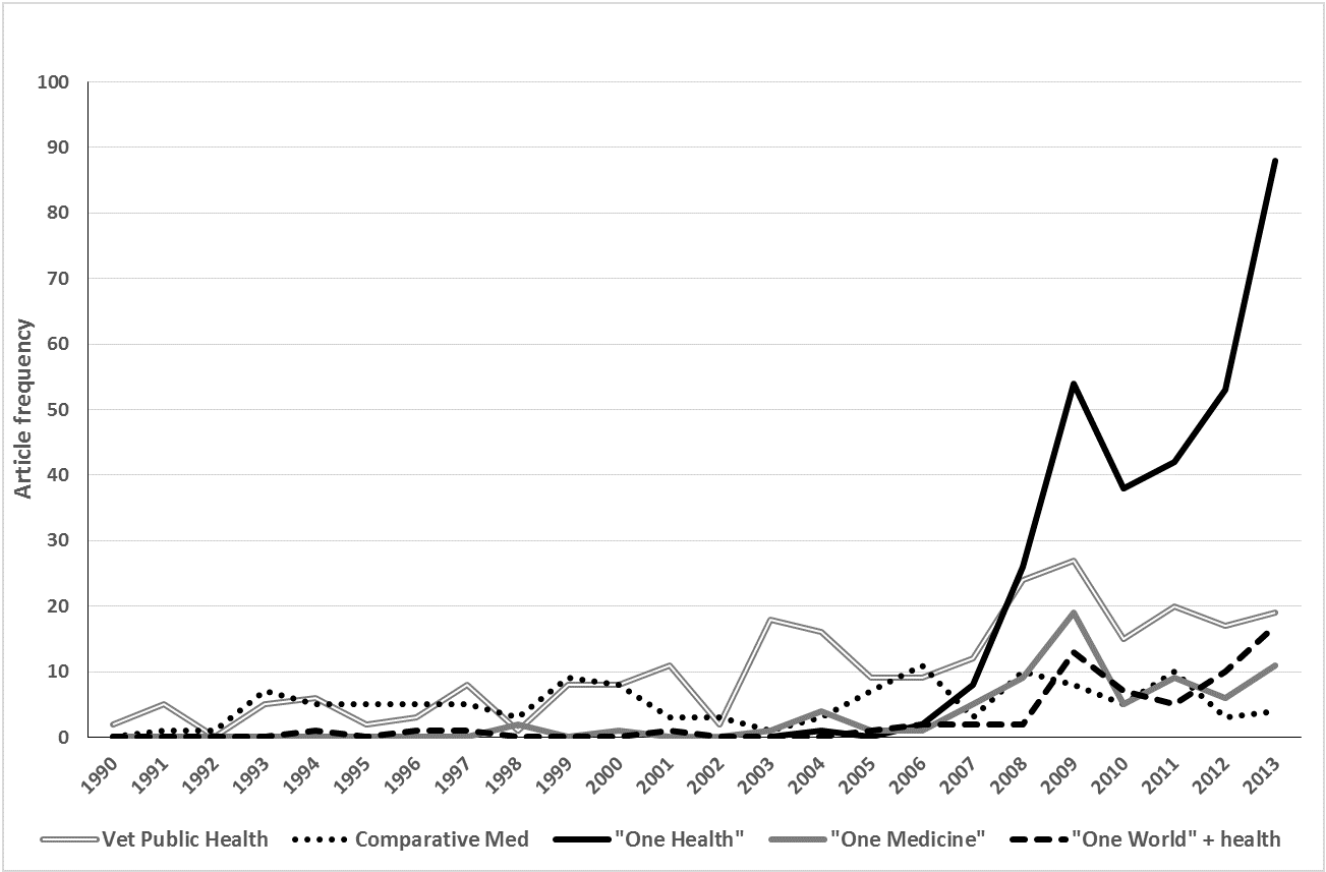

Fig. One: Frequency of journal articles using "One Health" and related search terms (source: Web of Science)

Even during 2008, it is clear that authors were starting to use OH as a standalone term, and following the FAO/WHO/OIE joint statement in 2010, OH overtook its predecessors and became adopted much more widely. Data for 2014 suggest an acceleration of this trend, with citations using the term OH nearly doubling to 173 a year, although usage of OM and OWOH persists at much lower levels.

So what happened to initiate this change and the more widespread uptake of OH? Adopting 'One Health' as a single term had advantages for both OM and OWOH advocates: it was less cumbersome, significantly broadened the scope of their shared agenda, and decentred disciplines. The idea of 'health' reaches far beyond infectious disease or clinical research, and encompassing a much broader range of issues, practices and policies than 'medicine' can. Many advocates have embraced the

flexibility of this expanded version of OH, adopting the 'umbrella' metaphor as a way of articulating the inclusive nature of the agenda (One Health Sweden, 2014). This shift was also driven by more pragmatic concerns: in 2008 the Wildlife Conservation Society registered the OWOH slogan as a trademark with the US Patent Office, preventing its usage by other organisations. Since 2010, a biennial international conference series and journal have been founded and activities have been sponsored by research funding bodies, philanthropic foundations and pharmaceutical companies. Moving out from its origins in the USA and Switzerland, OH meetings and associations have become increasingly international, appearing across Europe (Netherlands, Sweden), South East Asia (S. Korea, Malaysia), Australia and Africa (Ethiopia, Uganda). The ideas and terminology of OH have increasingly been used to facilitate inter-departmental cooperation in policymaking and government (CDC, 2013; Department of Health, 2013; Leung et al, 2012). In the UK at least, several universities have merged their veterinary, medical and biological sciences schools, referencing OH as part of the reason for these moves and launching new training programmes (RCVS, 2014; University of Surrey, 2012)

Qualitative examination of research articles, online material and policy reports mobilising OH can offer further insights into the recent expansion of the agenda, how this flexibility lends itself to multiple interests, contexts and agendas, and how different visions of interdisciplinarity are built into these texts. In biomedical, clinical and pharmaceutical contexts, OH tends to retain the OM model of collaboration or partnership between veterinary and human medicine. A good example of this can be seen in a recent statement from the UK's Biology and Biotechnology Research Council (BBSRC) - a UK government funding body: "BBSRC will also support […] the opportunities arising from taking a 'One Health' approach, in partnership with the MRC, to the support of multidisciplinary studies that underpin improvements in both human and animal health" (BBSRC, 2014). While BBSRC's central remit is biological sciences, the MRC is the corresponding Medical Research Council.

Similar articulations of OH as facilitating partnerships can also be seen in commercial biomedicine, where animal health is seen as an increasingly profitable area aiding the 'translation' of knowledge across the domains of the pharmaceutical, agricultural, research and clinical practice (Twine, 2013). OH advocates cite 'translational medicine' as an area where their approach can be of use, facilitating the movement of research insights and technical innovations between animal and human health (ImmunoValley, 2014). This move develops the longstanding role that veterinarians have played in 20th century biomedical research in maintaining the health of laboratory animals, previously described as 'comparative medicine' or 'laboratory animal science' (Kirk, 2010). Large-scale translational research programs such as the International Knockout Mouse Project have greatly increased the numbers of animals required, and intensified demand for scientifically trained veterinarians (Davies, 2012; Hendricks et al, 2009). In turn, this has reignited longstanding debates about the balance between research and clinical practice in veterinary education (Schwabe, 1984) and stimulated new training programmes (Gibbs, 2014). In these contexts, OH is invoked as a potential solution to a complex set of problems cutting across several disciplinary domains. However, just as with the earlier ideas of OM, this version of OH generally involves collaboration between well-established disciplinary specialists, and would probably be described by scholars of interdisciplinarity as cross or multi-disciplinary activity (Barry and Born, 2013).

Other UK funders such as the Wellcome Trust use OH primarily in connection with infectious diseases, continuing the OWOH idea that disease transmission between humans and animals can be better understood via an interdisciplinary approach (Wellcome Trust, 2010). In a similar fashion to the mutual invocation of OH and translational medicine, in global health contexts agendas such as such as 'health security' and 'biosecurity' appear alongside OH around topics such as antimicrobial resistance (Dept. of Health, 2013), influenza (Dwyer, and Kirkland, 2011) and Ebola (Gebreyes et al, 2014). Another key example of this can be seen in the case of 'food security' – the need to maintain an adequate food supply for human populations worldwide (FAO, 1996). A longstanding advocate of OH, the UN Food and Agriculture Organisation describe OH as a "unifying force to safeguard human and animal health" (FAO, 2011, p2). Just as with OH and translational medicine, this mutual deployment continues older collaborative connections: advocates of veterinary public health played key roles in mid-20th C WHO and FAO programmes to alleviate world hunger (Bresalier et al, 2015). Beyond the FAO, many other actors in food security do not mention OH: however OH advocates often cite food security as another example of a complex, interdisciplinary, global problem that their agenda can help to address (King et al, 2008). In a recent call for research proposals on tropical and infectious diseases, the global health funder Gates Foundation outlined their vision for OH: "If the artificial barrier that separates the fields of human and animal health could be broken down, many opportunities would emerge across the discovery-development-delivery spectrum for knowledge and practices in one field to accelerate progress in the other (Gates Foundation, 2013)." Such a radical vision of the sciences sees disciplinary identification largely as a barrier to progressing knowledge of health and disease, and continues the OWOH tradition of bringing together a broad range of disciplines beyond veterinary and human medicine. This could be more properly described as interdisciplinarity: indeed some OH advocates argue that they are moving beyond this to a 'transdisciplinary' model, also involving participatory research with local communities (Zinsstag et al, 2011).

Disciplines and interdisciplinarity in OH

While the uptake by institutions across human health, animal health and the environment has been clear, which journals have been publishing OH articles? Web of Science provides a classification of the journals covered by the database, enabling the results of keyword searches to be broken down by research field. Figure Two illustrates the distribution of journal articles published using OH and associated terms. This figure immediately demonstrates that even though OH aims to bring together human and animal health, these terms are most widely used by authors publishing in animal health (veterinary sciences). These differing distributions reflect the histories traced above: for example, comparative medicine was widely used in veterinary journals, but also across a range of biological (parasitology, zoology) and medical (infectious diseases, public health) research fields. Similarly OWOH has been visible in veterinary science but also in fields concerned with infectious disease such as immunology and microbiology. Reflecting its history as a veterinary led agenda, nearly 60% of the usage of OM has been in veterinary journals, with some mentions in medical research fields. What is most striking here is the distribution for OH itself, given that the majority of these articles were published since the consolidation of the agenda from 2008. An even higher proportion of the usage of OH has been in veterinary science journals, with some visibility in infectious disease and public health journals.

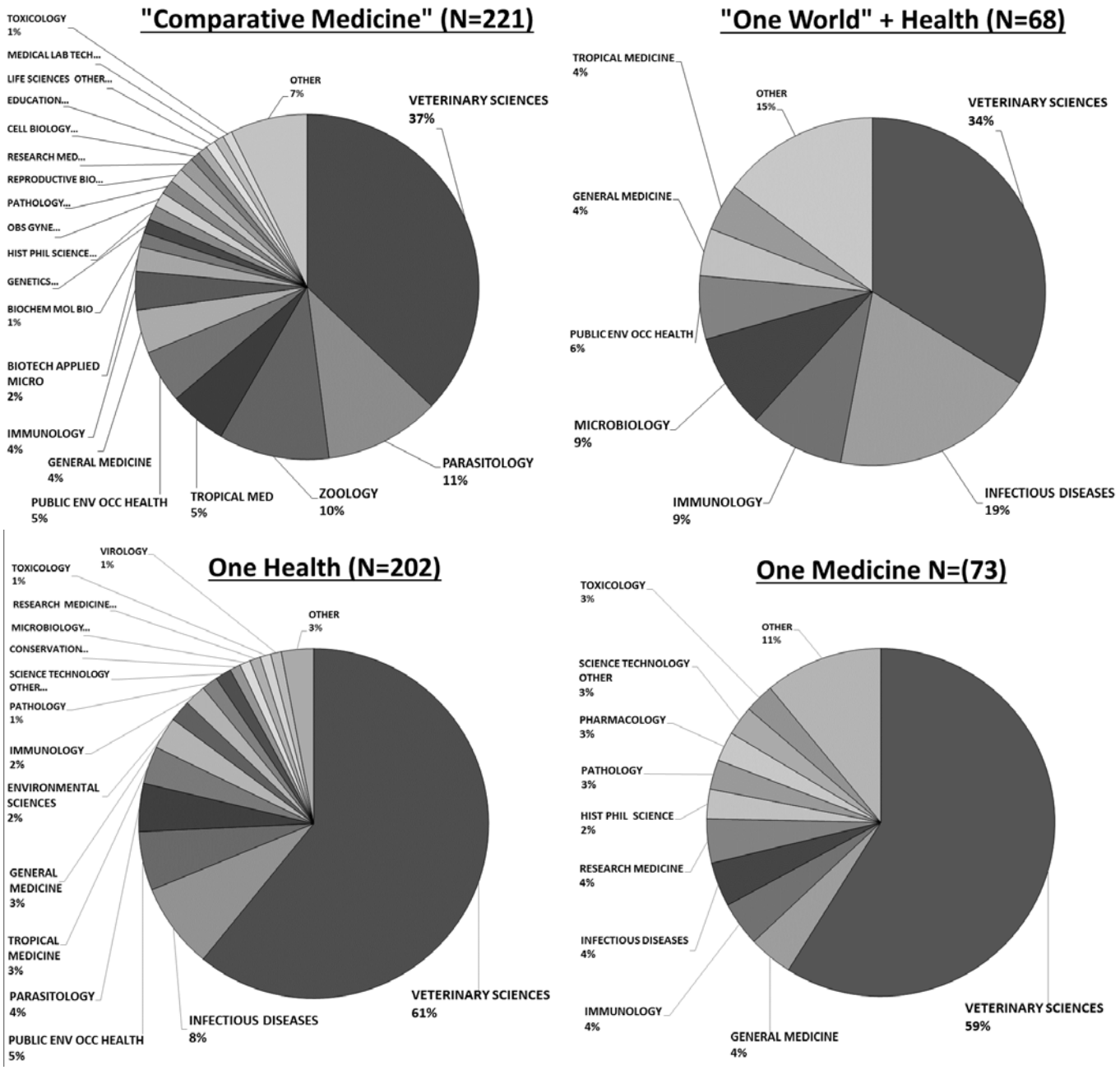

Figure 2. Disciplinary distributions of OH related search terms, 1970-2012 (source: Web of Science)

There are several key inferences to be drawn from this data. Firstly, while OH has been adopted by key policy and research institutions across multiple disciplines, its uptake by researchers beyond the veterinary sciences has been relatively limited. Secondly, the non-veterinary fields where it has been taken up are those with direct interests in key OH topics, particularly those related to infectious diseases. Finally, the differing fields allied to OM and OWOH reflect their orientations towards clinical medicine and global health/infectious diseases.

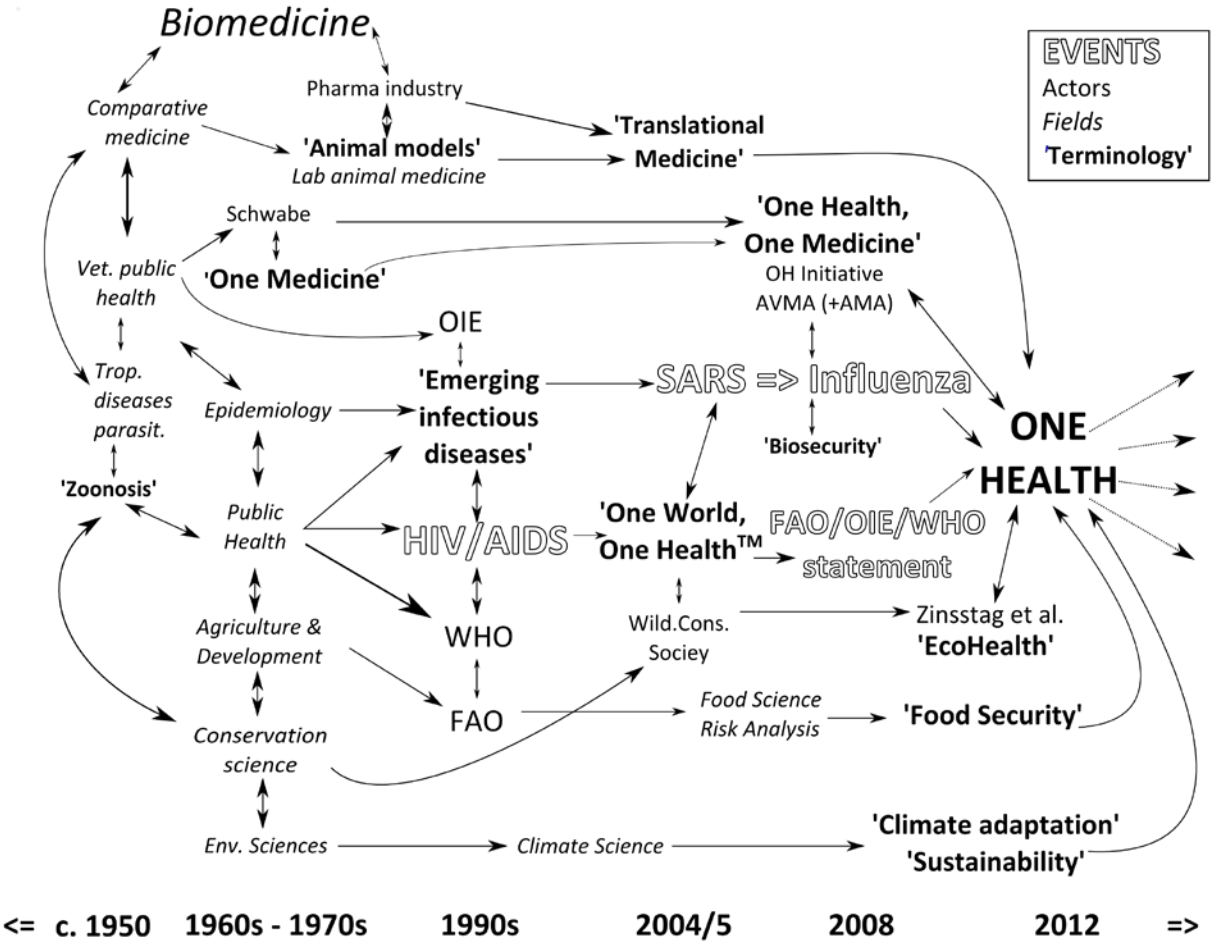

Figure 3. Scientific fields, actors, events and terminologies in the recent history of One Health.

Figure Three provides a diagrammatic representation of the complex of alliances which have come together to form One Health: something like an actor-network diagram, but with an added dimension of change over time. It depicts relations between the key actors, scientific fields and terminology involved in OH, the impact of disease events, and how these relations have changed over time, drawing upon the bibliometric data and historical analysis presented above. The upper part of the diagram shows the trajectory of 'One Medicine': its roots in comparative medicine and veterinary public health, its development by Schwabe and the parallel growth of animal models for human biomedical research. It then shows how these came together with the additional driver of translational research into 21st century OM, which then merged into OH. The central area shows the trajectory of 'One World, One Health', with its origins in comparative medicine, tropical diseases and the mid 20th C concept of zoonosis. WHO/FAO collaborations around animal health and food supply from the 1950s onwards provided a second point of interaction. HIV/AIDS created a central point of interaction between international health/development, infectious disease and conservation actors during the 1990s. SARS and pandemic influenza concerns then played a similar role during the 2000s, leading to the emergence of OWOH, and the eventual merger into OH. Finally, bottom of the diagram illustrates the relationship between OH and the environmental sciences. These have largely been separate, barring the interventions of the Wildlife Conservation Society, concerned with the

transmission of diseases to and from endangered wildlife. The transition to One Health has led to a much greater rhetorical emphasis on the environment, as it provides the obvious connection between humans and animals (although the data in fig 2 suggest that the connection has been more rhetorical than substantive). Advocates of 'EcoHealth' now position it as a successor to OH by foregrounding the importance of issues such as climate change and sustainability for health, reaching out to the environmental and social sciences (Zinsstag et al, 2011).

Discussion

This chapter has explored the emergence of 'One Health' (OH) and situated it within a history of advocacy for the convergence of human and animal health. It has followed the appearance and usage of the term, its recent and rapid uptake by powerful actors in global health and biomedicine, alongside the key actors, events, disciplines and fields involved. OH has come about through the merger of two overlapping yet distinct ideas about human and animal health: 'One Medicine' (OM) and 'One World, One Health' (OWOH). OM has its origins in 20th century traditions of veterinary advocacy for closer collaboration and partnership with human medicine, including comparative medicine and veterinary public health. In its contemporary form OM is particularly associated with clinical research, veterinarians working with laboratory animals, and translational research. OWOH originated in mid-20th century internationalism and the founding of international health agencies such as the WHO. 21st century OWOH advocates have included these agencies, conservation actors and researchers working with zoonotic disease: it is particularly associated with issues such as emerging infectious diseases and food security. OH has come about through the convergence of these interests towards the end of the 2000s, driven in particular by international responses to pandemic disease risks. Following this consolidation, OH has been adopted by a series of powerful institutional actors in global health, research funding and policy, and the rate at which the term is used in academic journals has rapidly increased. As Leboeuf (2001) and Chien (2013) and have argued, the flexibility of OH has meant the term acts as a boundary-object, enabling actors across multiple social worlds (including academic disciplines) to reinterpret the agenda to suit their own interests, driving this convergence.

This pattern – of slow emergence, intense negotiation including the use of boundary-objects, consolidation, followed by widespread adoption – fits well with Fujimura's (1992; 1996) concept of the 'scientific bandwagon', originally applied to the rise of molecular biology. The increasing adoption of OH by institutional actors across human health, animal health and environmental issues also suggests that it has been a highly successful bandwagon, achieving its aim of facilitating interdisciplinarity across these domains. However, the data on usage of OH terminology in academic journals tells another story. This indicates that discussions of OH have mostly been published in veterinary journals, only appearing in non-veterinary fields with adjacent interests (e.g. infectious diseases, public health). As we have seen, the OH agenda has its roots in longstanding traditions of advocacy not only for veterinary-medical partnership, but also for boosting the status and defending the boundaries of the veterinary profession, which remains small, sparsely funded and under-regulated in comparison to human medicine (Hobson-West and Timmons, 2015). Given this historical background of rivalry and status anxiety, combined with success in attracting the support of institutional actors including research funders, it is perhaps unsurprising that OH has faced criticism

from medical actors seeing it as a veterinary 'land-grab' (Institute on Science for Global Policy, 2012). This lack of movement into research practice is reflected in the current literature on OH, which tells a tale of anxiety and argument about how the agenda can move from 'rhetoric' to 'reality' (Okello et al, 2011; Gibbs, 2014).

The positioning of OH alongside a range of contemporary – and usually more prominent – agendas across science, medicine and policy can offer further clues about OH, interdisciplinarity and bandwagons. As we have seen, the OH literature often references terms including 'food security', 'health security' 'emerging infectious diseases' and 'translational medicine', arguing that OH can provide solutions for problems in these areas. Like OH, these terms refer to new scientific and policy agendas, arguing for applied research about the world's highly complex 'wicked problems' which cut across traditional disciplinary domains (Brown et al, 2010). Like OH, these agendas provide 21st century articulations of longstanding 20th century concerns (e.g. 'world hunger' becomes 'food security'), and interdisciplinarity is seen as a key solution. Each of these address a set of concerns which overlap with OH, but oriented towards a different cluster of disciplines – although OH is unique in bridging the biomedical and environmental/agricultural sciences. Rather than competing, these agendas appear to be mutually reinforcing, so arguments for OH draw upon arguments for food security or translational medicine and (at least some of the time) vice versa. The secondary literature on these agendas offers further intriguing parallels with OH: for example analyses of the discourse around food security describe it as a 'master frame' (Mooney and Hunt, 2009) which is deliberately broad and flexible, enabling framings and reframings by multiple actors leading to an ultimate, if fractured, consensus (May and Kirwan, 2013). This and similar work on global health (King, 2004; Scoones and Forster, 2009), translational medicine (Yaqub and Nightingale, 2012), biosecurity (Dobson et al, 2013) and OH itself (Craddock and Hinchcliffe, 2015) argues that the dominant framings of these agendas are strategic and political, working in favour of industry and large institutional actors, often at the expense of local communities and non-profit solutions.

To return to the question of bandwagons, I argue that while OH shares many features of Fujimura's 'scientific bandwagon', there are some key differences. In particular, OH is overtly interdisciplinary in its ambitions, extends beyond science into the policy sphere and appears to have been constructed, aimed at and taken up by large institutional as well as individual scientific actors. The bibliometric data suggests that the relationship between OH and scientific or clinical practice appears to be rather distanced, particularly beyond veterinary science. To put it into the terms posed by Jacobs and Frickel, OH started as a 'bottom-up' movement, but as such has largely been (and remains) a deeply disciplinary concern, working to increase the status and resources of veterinarians. OH then became interdisciplinary via powerful institutional actors in biomedicine, transforming into a 'top-down' agenda, to the point that some veterinarians now express concerns that they will merge back into the biomedical sciences, overtaking their own interests (RCVS, 2014, p10). The parallels between OH and adjacent agendas such as global health, food security and translational medicine suggest that all of these may be examples of a new style of agenda building: the 'interdisciplinary bandwagon'. Unlike the molecular biology bandwagon, which appealed to scientists in multiple disciplines by providing new techniques and ideas useful in day to day research practice, interdisciplinary bandwagons operate by providing mechanisms for institutions to work together, gathering funding and visibility along the way (Caulfield and Condit, 2012)

This may explain why the language of interdisciplinarity across contemporary academia and policy tends to be so uniform and unreflective (Barry and Born, 2013; Jacobs and Frickel, 2009), particularly in institutional contexts: it serves to "iron out the mess of actually working together" (Donaldson, Ward and Bradley, 2010, p1525), enabling the bandwagon building process. If this is so, then interdisciplinary bandwagons may even be an impediment to fostering practical engagement across specialisms, and as we have seen with OH, carry with them strongly disciplinary interests, potentially creating resistance and resentment elsewhere. As we have seen elsewhere in this volume, even the meaning of 'interdisciplinarity' itself is open to multiple, sometimes conflicting interpretations which vary according to context and research field (Downey et al, this volume). While the impulse to elide these differences is understandable, it may contribute to misunderstandings and tensions between collaborators when they start working together on a day to day basis. Histories of interdisciplinary collaboration suggest that successful work in this mode has been driven by practical concerns such as shared research questions, exchanges of materials and methods, sociable working relationships, and supportive institutional settings (Aicardi, 2014; Schlich, et al, 2009), albeit still with a partial understanding of what works, when and why. While OH discussions of the need to move 'from rhetoric to reality' suggests some awareness of these tensions, OH actors have rarely discussed the potential steps which could be taken to facilitate collaborative research or clinical practice in particular situations.

In order to move their agendas forward, advocates of OH and other interdisciplinary bandwagons would benefit by learning from how scientists have successfully managed to work together across disciplines in the past. This includes the institutional, material, political, linguistic and financial factors contributing to an 'epistemic culture' of collaboration (Smith-Doerr et al, this volume). In other words, paying close attention to the particularly social nature of science may help to support the success of such endeavours long after the interdisciplinary bandwagon has rolled on.

Notes

[1] 'One Medicine? Investigating human and animal disease c. 1850-2015' is a five year collaborative project funded by Wellcome Trust (PI Prof. Abigail Woods, grant no. 092719), involving an STS scholar working with a group of historians of veterinary medicine, human medicine, and biology. I would like to thank my colleagues on the project for their support and invaluable contributions to the development of this analysis.

[2] Following e.g. Barry and Born (2014), I will take 'interdisciplinary' to indicate approaches which combine perspectives from multiple fields, while 'cross-disciplinary' will indicate approaches where multiple field collaborate but retain their distinct identities. It is worth noting that many scientific and policy actors, including those involved in OH, have a tendency to use terms such as inter/cross/multi/transdisciplinary almost interchangeably.

[3] Adele Clarke (1991, p 131) defines social worlds as follows: "groups with shared commitments to certain activities, sharing resources of many kinds to achieve their goals, and building shared ideologies about how to go about their business".

[4] WCS, originally the New York Zoological Society, was founded in 1895, runs several wildlife parks and zoos in the USA, and undertakes international conservation research, campaigning and activism.

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